

## Extracting *in situ* cosmogenic $^{14}\text{C}$ from olivine: significance for the CRONUS-Earth project

JEFFREY S. PIGATI Department of Geosciences, University of Arizona, Tucson AZ 85721

NATHANIEL A. LIFTON Department of Geosciences, University of Arizona, Tucson AZ 85721

JAY QUADE Department of Geosciences, University of Arizona, Tucson AZ 85721

A.J. TIMOTHY JULL Arizona-NSF AMS Facility, University of Arizona, Tucson AZ 85721

One of the main goals of the Cosmic-Ray-prOduced NUclide Systematics on Earth (CRONUS-Earth) project is to compare production rates of *in situ* cosmogenic nuclides (CNs) at several well-dated locations in various rock types. Quartz is the most commonly used target mineral for several CNs (e.g.,  $^{10}\text{Be}$ ,  $^{26}\text{Al}$ ,  $^{21}\text{Ne}$ ,  $^{14}\text{C}$ ), but is generally absent in mafic volcanic terrains, where flows of different ages can constrain temporal variations in CN production at a given location. Because of its short half-life (5.73 ka), *in situ* cosmogenic  $^{14}\text{C}$  (*in situ*  $^{14}\text{C}$ ) can be particularly useful for elucidating temporal variations in CN production over much shorter time scales than other CNs. While CNs such as  $^{36}\text{Cl}$  and  $^{21}\text{Ne}$  can be measured in both mafic and felsic rocks, clearly it would be advantageous to measure *in situ*  $^{14}\text{C}$  in mafic rocks as well.

As such, we have worked to develop reliable protocols to extract *in situ*  $^{14}\text{C}$  from olivine. We conducted numerous stepped combustion experiments testing the efficacy of various chemical pretreatments. We were able to extract a stable and reproducible *in situ*  $^{14}\text{C}$  component from olivine using a  $\text{LiBO}_2$  flux, following pretreatment with dilute  $\text{HNO}_3$ . However, measured concentrations in olivine (normalized to  $\text{SiO}_2$  composition) from two known-age basalt flows, the Tabernacle Hill flow ( $17.3 \pm 0.4$  ka in age) in central Utah and the McCarty's flow ( $3.0 \pm 0.2$  ka in age) in western New Mexico, were 3 to 5 times lower than predicted *in situ*  $^{14}\text{C}$  concentrations based on measurements in quartz. This discrepancy appears to arise from (1) a synthetic spinel-like mineral formed during our extraction process by the chemical interaction of the  $\text{Al}_2\text{O}_3$  sample boat and olivine dissolved within the  $\text{LiBO}_2$  flux, and (2) undissolved pyroxene phenocrysts (difficult to separate in quantity from olivines). Although we do not fully understand how the formation of the synthetic mineral may affect carbon atoms liberated from olivine, the concentration of *in situ*  $^{14}\text{C}$  atoms that we measured is directly proportional to the Fe-to-total-cation (Fe:TC) ratio of each sample. After applying simple correction factors based on the Fe:TC ratio and the percentage of pyroxene in the sample, measured *in situ*  $^{14}\text{C}$  concentrations were indistinguishable from predicted values at both calibration sites. Because the mineralogical composition (~30% fayalite, 70% forsterite) of the olivines studied here is common in basalt flows elsewhere and the Fe:TC correction factor appears to be predictable, *in situ*  $^{14}\text{C}$  can now be applied to CN research in basaltic terrains, complementing other CN measurements made for CRONUS-Earth.